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Indian Standard

AIRCRAFT — PERFORMANCE REQUIREMENTS FOR LEVER OPERATED MANUAL SWITCHES (CLASS 1 AND 2) — SPECIFICATION

UDC 629·7·064 : 621·316·542 : 620·16

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Aircraft Electrical Equipments Sectional Committee, TED 15

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Aircraft Electrical Equipment Sectional Committee had been approved by the Transport Engineering Division Council.

In the preparation of this standard, assistance has been derived from ISO 1466 : 1973 'Lever-operated manual switches for aircraft — performance requirement', issued by International Organization for Standardization (ISO).

For the purpose of deciding, whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

AIRCRAFT — PERFORMANCE REQUIREMENTS FOR LEVER OPERATED MANUAL SWITCHES (CLASS 1 AND 2) — SPECIFICATION

1 SCOPE

This standard specifies the performance requirements for the single hole fixing lever operated manual switches for use in nominal 28 V dc and 115/200 V three phase 400 hz ac systems in aircraft.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
7855 : 1975	Form of declaration of performance of aircraft electrical equipment
8252 (Part 6) : 1976	Environmental tests for aircraft equipment: Part 6 Waterproofness
9174 : 1979	Dimensions for single-hole mounted lever-operated switches for aircraft

3 CLASSIFICATION AND DESIGN REQUIREMENTS

3.1 The switches shall be of the following classes:

Class 1 — Switches which are sealed and are suitable for use at altitudes up to 21 400 m and temperatures within the range $-40°$ to $+70°$ and which do not suffer damage or deterioration when subjected to $-65°C$,

Class 2 — Switches which are sealed only at the lever entry and are suitable for use at altitudes up to 6 100 m and for occasional use at 18 300 m and at temperatures within the range $-20°$ to $+55°C$ and which do not suffer damage or deterioration when subjected to $-40°C$.

3.2 The switches shall be suitable for mounting through the panel from the rear and shall operate satisfactorily when mounted in any attitude.

3.3 The switches may be the two or three-position type, with one or more poles; it may be self-retaining and/or spring return. These shall preferably be designed to allow the incorporation of integral locking of the lever in any or all positions.

3.4 The method of operation of the switches shall be by means of a single lever, moving in a plane at right angles to the mounting panel. The relationship of the lever positions to the keyways, and the relationship of the terminal numbers to the lever positions shall be stated in the specification applicable for the class of switch.

3.5 The switch terminals shall be identified by number in the sequence shown in the specification applicable for the class of switch.

4 DIMENSIONS

4.1 The envelope and fixing dimensions for the switches shall be as specified in IS 9174 : 1979.

5 OPERATION

5.1 The switch lever action shall be positive and it shall not be possible during normal usage for the lever to stay in any position other than a fully operated position. The operation of the switch shall not be affected adversely by the speed of the movement of the lever.

5.2 It shall not be possible to rotate the lever about its longitudinal axis.

5.3 The angular movement of the leer shall be between 18 and 23° nominally from the centre position with a tolerance of ±2°.

5.4 There shall be at least a 10° movement of the lever before switching occurs.

5.5 The lever shall be capable of withstanding without damage or distortion a force of 90 N applied steadily in the directions stated in **11.9.2**.

6 CONSTRUCTION

6.1 The lever, including any metal inserts, shall be insulated from all live parts.

6.2 The manufacturer shall declare the maximum and minimum values of the operating force for each operation appropriate to each type of switch.

The force required to operate the switch shall be not less than 4·5 N and not more than 45 N.

For each operation of a particular type of switch the maximum force shall not exceed the minimum force by more than 100 percent.

6.3 Where locking of the lever is provided it shall be positive and automatic, and the lock shall be released by raising the lever against a spring force of 4·5 to 22·5 N.

6.4 The exposed portion of the switch shall have a non-glaring finish.

6.5 The switches shall be sealed at the point of entry of the lever to prevent the ingress or liquids of foreign matter. The bodies of class 1 switches shall, in addition, be sealed.

6.6 Terminations shall be by screws, each capable of accepting two crimped tag-type terminations of approved design. The terminal threads shall be M4 × 0·7. Terminals shall have a mechanical strength adequate to satisfy the requirements of **11.9.1**.

6.7 The terminal arrangement shall be such that wiring access is still provided when the switches are mounted in rows at minimum spacing. Means shall be provided to avoid accidental contact or short-circuiting between adjacent terminals or cable lugs.

The switches shall be suitable for close mounting and shall not constitute an electrical hazard if the side faces of adjacent switches touch one another.

6.8 The switch shall be mounted by means of a threaded bush, with a locating keyway in the plane of movement of the lever, suitable for use with the panel mounting hole specified in IS 9174 : 1979. Two hexagon mounting nuts, one locating washer and one internal shakeproof washer shall be provided with each switch.

6.9 The switch shall be so constructed that it is suitable for performing at least 50 000 operations at maximum rated current and voltage.

6.10 The switch contacts, including common internal connections, shall be self-wiping on all switched contact positions. Springs shall be of the compression type.

6.11 The lever mechanism shall incorporate a positive contact opening action in order to assist in breaking a tack weld.

6.12 The appropriate contacts only shall operate when the lever is suddenly released from a spring-loaded position.

7 RATINGS

7.1 Voltage

The switch shall be suitable for operating in nominal 28 V dc and 115/200 V three-phase, 400 Hz ac systems. In addition, the switch shall be suitable for use at voltages down to **4** V dc or ac.

7.2 Current

The switch shall perform at least 50 000 operations and shall be suitable for any one of the following nominal current ratings:

Resistive load	15 A
Inductive load	10 A
Tungsten filament lamp load (28 V dc)	7·5 A
Tungsten filament lamp load (200 V ac)	2·5 A

7.3 In addition, unless otherwise declared, the switch shall be suitable for operation at 100 mA resistive load at voltages down to **4** V.

The inductive loads shall be as follows:

28 V dc — 10 A, 40 mH

115/200 V ac — 10 A, 0·75 to 0·80 power factor, lagging.

8 GENERAL CONDITIONS OF TEST

8.1 All tests referring to ac voltages relate to 200 V (line to line) for multi-pole switches, and to 115 V (phase) for single-pole switches.

All electrical tests shall be performed with the switch connected on each side with cable of a cross-section compatible with the required current. Except for the test in **11.14** each cable shall be attached to the switch using a crimped termination of approved design and at least 915 mm in length.

8.2 Unless otherwise stated, the test shall be made at a temperature between 15 and 30°C, pressure of 93 to 106 kPa (933 to 1 060 m bar), and at a relative humidity not exceeding 90 percent.

8.3 A cycle of operation shall consist of movement of the lever from one extreme position to the other and return to the original position. Levers of switches of the spring-return type shall be allowed to return to the biased position with hindrance or assistance from the operating device. The times spent in each position shall be approximately equal.

9 DECLARATION OF PERFORMANCE

9.1 The information about the performance of the switch shall be declared in the standard form of declaration as per IS 7855 : 1975. This will include the following:

a) classification;

b) the limits of the forces necessary to operate the switch to any position;

c) the switch operation relative to lever position and terminal numbering; and

d) the system of batching used for quality test sampling.

10 SAMPLING

10.1 A recommended scheme of sampling is given in Annex A.

11 TESTS

11.1 Type Tests

The following shall constitute the type tests:

- a) Visual examination (*see* **11.4**),
- b) Dimensions (*see* **4.1**),
- c) High voltage test (*see* **11.5**),
- d) Insulation resistance test (*see* **11.6**),
- e) Voltage drop test (*see* **11.7**),
- f) Operating forces test (*see* **11.8**),
- g) Mechanical strength test (*see* **11.9**),
- h) Temperature rise test (*see* **11.10**),
- j) Mechanical endurance test (*see* **11.11**),
- k) Electrical endurance test (*see* **11.12**),
- m) Overload test (*see* **11.13**),
- n) Short circuit test (*see* **11.14**),
- p) Lever bush sealing test (*see* **11.15**),
- q) Environmental test (*see* **11.16**), and
- r) Strip examination and report (*see* **11.17**),

11.1.1 The tests specified in **11.1**(a) to (f) shall be carried out on the same switch. A separate switch shall be used for each of the test specified in **11.1**(g) to (r).

11.2 Acceptance Test

The following shall constitute the acceptance tests:

- a) Visual examination,
- b) Dimensions,
- c) High voltage test,
- d) Insulation resistance test,
- e) Voltage drop test,
- f) Operating forces test,
- g) Mechanical strength test,
- h) Temperature rise test, and
- j) Overload test.

11.3 Routine Tests

The following shall constitute the routine tests:

- a) Visual examination,
- b) Dimensions,
- c) High voltage test,
- d) Insulation resistance test, and
- e) Voltage drop test.

11.4 Visual Examination

The switch shall be examined for the requirements of **5** and **9**. The quality/workmanship shall be visually inspected.

11.5 High Voltage Test

A test voltage of 1 500 V rms at 50 Hz shall be applied for a period of not less than 5 seconds between:

- a) each terminal and all others not connected to it with the lever in each position, and
- b) all terminals connected together and the metal mounting plate and any exposed metallic parts with the lever in each position.

During the test, the voltage shall be increased and decreased gradually.

11.6 Insulation Resistance Test

Immediately after the high voltage test, the insulation shall be measured at a potential of 500 V dc between the points specified in **11.5** (a) and (b) and shall not be less than 100 MΩ.

11.7 Voltage Drop Test

A current of 15 A dc shall be passed through the contacts at a suitable voltage. The voltage drop across the switch terminals shall be measured and shall not exceed 100 mV with the exception of spring return switches, no force shall be applied to the lever during the test.

11.8 Operating Forces Test

The forces necessary for the operation of the switch to all operating positions shall be determined. The force shall be applied at 3 mm from the tip of the lever and at right angles to the lever axis. The test shall be repeated three times in each lever direction. The forces to operate and, if appropriate, to unlock the lever shall be within the limits declared by the manufacturer.

11.9 Mechanical Strength Test

11.9.1 All terminals shall be subjected for not less than one minute to:

- a) a pull of 45 N in each of the following directions:
  - — parallel to the long axis of the terminal screw;
  - — at right angles to the long axis of the terminal screw; and
- b) a torque of 1·8 N.m applied to the terminal screw.

11.9.2 *Strength of Lever*

A force of 90 N load shall be applied for not less than 1 minute to the lever under each of the following conditions, during which the switch shall be connected electrically to check contact operation:

a) perpendicular to the lever axis and parallel to the line of lever travel at each end-position of the lever;

b) perpendicular to the plane of travel in both directions throughout the entire range of lever travel;

c) coaxial with the lever axis toward and away from the switch body throughout the entire range of lever travel; and

d) for locked lever switches, perpendicular to the lever axis in the plane of travel and in the direction to cause operation. The lever shall remain in the locked position.

For the tests in (a), (b) and (c) the load shall be applied 3 mm from the tip of the lever.

11.9.3 *Strength of Panel Mounting Bush*

A tightening torque of 3·6 N.m shall be applied for not less than 1 minute to the mounting nut with the switch mounted in a panel and located by means of the locating washer and key-way.

11.9.4 The switch shall not be damaged or distorted as a result of the tests defined in **11.9.1** to **11.9.3**, immediately following which it shall:

a) satisfy the requirements of the insulation resistance test (*see* **11.6**);

b) perform satisfactorily 10 cycles of operation at 28 V dc; and

c) satisfy the requirements of the lever bush sealing test (*see* **11.15**).

11.10 Temperature Rise Test

11.10.1 The switch, suspended in still air, shall carry 15 A dc until steady conditions are reached. The temperature or temperature rise of any external part of the switch shall not exceed the figures stated in **11.10.2** and **11.10.3** below. The temperature rise in the attached cable (measured with a suitable thermocouple at the surface of the conductor beneath the insulation at the point 25 mm from the end of the insulation) shall not exceed 55°C. For multi-pole switches the temperature shall be measured with all normally closed poles carrying rated current.

11.10.2 The temperature of any component part of the switch which may normally be accessible to, or inadvertently touched by, occupants of the aircraft under operating conditions shall not exceed 100°C at maximum ambient temperature.

11.10.3 The temperature rise of any part which is necessarily handled and which is made from, or covered with, material which is a poor thermal conductor, shall not exceed 20°C. If such a part is made from metal the temperature rise shall not exceed 10°C.

11.11 Mechanical Endurance Test

Two switches shall each be subjected to 100 000 cycles of no-load operation as follows, at a rate between 20 and 30 cycles per minute for two-position switches and between 10 and 15 cycles per minute for three-position switches:

Class 1

a) 80 000 cycles at + 20 ± 5°C

b) 10 000 cycles at + 70 ± 2°C

c) 10 000 cycles at − 40 ± 2°C

Class 2

a) 80 000 cycles at + 20 ± 5°C

b) 10 000 cycles at + 55 ± 2°C

c) 10 000 cycles at − 20 ± 2°C

NOTE — For spring-return switches, return from the momentarily actuated position is to be accomplished solely by the internal mechanism of the switch without hindrance or assistance by the operating device. When testing other types of switch, the operating device is not to impart a load to the switch lever in any fixed position of the lever.

Following these tests, the switches shall satisfy the requirements of the voltage drop and insulation resistance tests described in **11.5, 11.6** and **11.7** and there shall be no mechanical breakage, malfunction, or deterioration of the lever seal, when tested in accordance with **11.8**, **11.9** and **11.15**.

11.12 Electrical Endurance Test

11.12.1 Twelve switches shall each of subjected to at least 50 000 cycles of operation as follows, at a rate between 10 and 12 cycles per minute for two-position switches and between 5 and 6 cycles per minute for three-position switches, voltage drop at rated current being checked every thousand cycles and not to exceed 150 mV between terminals.

Class 1

a) 25 000 cycles at sea level;

b) 24 000 cycles at a pressure corresponding to an altitude of 11 000 m; and

c) 1 000 cycles at a pressure corresponding to an altitude of 21 400 m.

Class 2

a) 25 000 cycles at sea level;

b) 24 990 cycles at a pressure corresponding to an altitude of 6 100 m; and

c) 10 operations at a pressure corresponding to an altitude of 18 300 m.

During the tests the sample switches shall carry loads as follows:

Number of Samples	*Load (100 percent)*
2	dc resistive
2	ac resistive
2	dc inductive
2	ac inductive
2	dc lamp
2	ac lamp

11.12.2 Two switches shall each be subjected to 50 000 cycles of operation as follows at the rate specified in **11.12.1**, carrying a 100 mA resistive load at 2 to 4 dc. The voltage drop measured between terminals at this current shall be checked every thousand cycles, and shall not exceed 2 mV per set of contacts, or 4 mV per two sets of contacts in series:

a) 25 000 cycles at sea level; and

b) 25 000 cycles at a pressure corresponding to an altitude of 6 100 m.

11.12.3 After the above tests, the switches shall be visually examined. There shall be no mechanical damage or breakage to the switch.

The insulation resistance of the switches shall be determined. This value shall not be less than the value specified in **11.6**.

11.13 Overload Test

11.13.1 The switch shall be subjected to 50 cycles of operation at the appropriate rate specified in **11.12.1** controlling 200 percent resistive current at 28 V dc.

11.13.2 The switch shall be subjected to 50 cycles of operation at the appropriate rate specified in **11.12.1** controlling 200 percent resistive current at 115/200 V ac.

11.14 Short Circuit Test

11.14.1 Switches shall be subjected to the following short-circuit test in a circuit equivalent to that shown in Fig. 1. The circuit shall be adjusted to provided a current of 60 times the rated resistive current at 28 V dc with the selector switch in the calibrate position. For three-position switches, a separate switch may be used for testing each operating position.

11.14.2 *Closed Circuit Test*

The switch under test shall be inserted in the test circuit with its contacts closed, the selector switch set to test, and the circuit-breaker closed. The control switch shall then be closed to initiate the fault current and held closed until the circuit-breaker clears the fault. The fault current shall be applied five times with a minimum interval of 2 minutes between each test.

11.14.3 *Making Circuit*

The switch under test shall be inserted in the test circuit with its contacts closed, the selector switch set to test, and the circuit-breaker closed. The switch under test shall then be closed to initiate the fault current and held closed until the circuit-breaker clears the fault. The switch shall then be opened on no-load.

For the tests defined in **11.14.2** and **11.14.3**, the contacts shall not weld or stick and there shall be no mechanical damage to the switch. After the tests the voltage drop across the contacts shall be measured in accordance with **11.7** and shall not exceed 150 mV.

11.15 Lever Bush Sealing Test

11.15.1 The switch shall be mounted on a horizontal panel with the threaded bush uppermost and shall have water at a temperature not less than 90°C poured upon it from a height of 150 to 300 mm above the switch mounting face so that the water may enter the switch lever cavity. The switch shall be operated ten times while wet and carrying 15 A dc. This cycle of operations shall be repeated five times with a 10 min interval after each cycle.

11.15.2 At the conclusion of the test cycles and after removal of moisture by wiping, the voltage drop measured in accordance with **11.7** shall

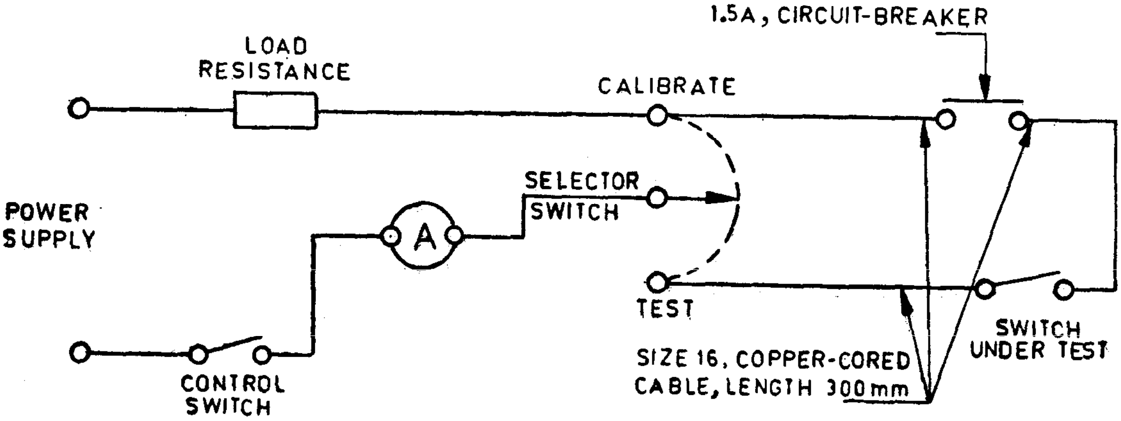

Fig. 1 Typical Test Circuit for Short Circuit Test

not exceed 150 mV and the insulation resistance shall be not less than 20 MΩ between terminals and switch ferrule.

11.15.3 Between 2 and 4 h after the conclusion of the tests the switch shall be stripped and examined in accordance with **11.17**. There shall be no deterioration of the lever seal, and no signs of moisture inside the switch.

11.16 Environmental Tests

11.16.1 The switches shall meet the requirements of the following:

a) Vibration,
b) Acceleration,
c) Explosion proofness,
d) Resistance to action of aircraft fluids,
e) Fire resistance,
f) Waterproofing [in accordance with IS 8252 (Part 6) : 1976],
g) Radio interference,
h) Compass interference,
j) Salt,
k) Sand dust,
m) Fungus growth, and
n) Humidity.

NOTE — Till such time, Indian Standards on environmental tests for aircraft equipment are made available, the requirements for the above test shall be subjected to agreement between the manufacturer and the purchaser.

11.17 Strip Examination and Report

11.17.1 Upon completion of type tests, each sample switch shall be opened and examined for any sign of excessive wear. A report of the condition of the switch shall be submitted to the inspection authority.

12 MARKING

12.1 The following data shall be marked on each switch in such a position where it can be easily read:

a) Indicating the source of manufacture,
b) Manufacturer's type number,
c) Rated voltage, that is, 28 V/200 V,
d) Rated current, for example, '15 A res' (res = resistive), and
e) Batch No., or serial No.

ANNEX A

(*Clause* 10)

SAMPLING PROCEDURE FOR ACCEPTANCE TESTS

A-1 LOT

A-1.1 In any consignment, all switches of the same make, rating and type and manufactured under similar conditions of production shall be grouped together to constitute a lot.

A-2 SELECTION OF SAMPLE

A-2.1 The number of switches to be selected from the lot shall depend upon the size of the lot and shall be in accordance with col 2 of Table 1. All the switches so selected shall be subjected to the acceptance tests specified in **11.2**.

Table 1 Sample Size and Criterion for Conformity

(*Clauses* A-2.1 *and* A-3.1)

Lot Size (1)	First Sample N_1 (2)	Second Sample N_2 (3)	Acceptance Number C_1 (4)	Rejection Number C_2 (5)
Up to 50	5	10	0	2
51 to 100	7	14	0	2
101 to 200	10	20	0	3
201 to 300	13	26	0	3
301 to 500	20	40	1	4
501 and above	25	50	1	5

A-3 CRITERION FOR CONFORMITY

A-3.1 The lot shall be considered as conforming to the requirements of acceptance tests if the number of failures in the first sample is less than or equal to acceptance number C_1 given in col 4 of Table 1. If the number of failures is greater than or equal to the rejection number C_2 as given in col 5 of Table 1, the lot shall be considered as not conforming to the requirements of the acceptance tests.

A-3.2 If the number of failures is between C_1 and C_2, a further sample of N_2 switches shall be selected and subjected to the acceptance tests. If the number of failures in the two samples combined is less than C_2 the lot shall be considered as conforming the requirements of acceptance test, otherwise not.

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BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75
Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices : Telephone

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002 { 331 01 31, 331 13 75

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola
CALCUTTA 700054 37 86 62

Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036 53 38 43

Southern : C.I.T. Campus, IV Cross Road, MADRAS 600113 235 0216

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